North Carolina's

Marine Science & Education Partnership

Director's Message

A New Course for Carteret County

Carteret County, it seems, has just discovered gold. Or at least its economic equivalent.

In the search for clean growth industries, the spotlight has landed upon the county's heretofore unrecognized wealth of marine science operations.

The multitude of research and education efforts in this field has underpinned our economy for decades. But the extent of these activities – and the potential they promise – have gone largely unnoticed until now.

Dave Inscoe

The Economic Development Council and several of the leading marine science organizations – the Marine Science and Education Partnership (MSEP) – recently collaborated to gauge the scope and the impact of these many and diverse pursuits. Their goal in taking stock was to portray a comprehensive picture of marine science efforts here, thereby highlighting opportunities for related new ventures and new jobs.

The partnership represents the spectrum of marine science operations in the county. It includes a federal marine laboratory, state and private university laboratories and outreach programs, a community college, a state regulatory agency and public attractions that provide educational programs.

As evidenced by the reports included in this publication, the results of the economic inventory MSEP commissioned are stunning. The totals will swell further in coming years as several of these organizations fulfill ambitious construction and expansion goals.

And the numbers presented here depict the impact only of the MSEP partners. A complete marine science roll call constitutes a much longer list. Carteret County in some circles is known as the Southern equivalent of well-known marine science meccas such as Woods Hole in Massachusetts and California's Scripps.

Yet, for all they contribute, most of these places ask next to nothing from local governments. What they give back is not limited to monetary impact, nor to the area. The science emanating from Carteret County affects public health, public safety and public policy at the local, state, national and even global levels. The profiles of MSEP partners that follow in this publication provide a glimpse of the fascinating and essential work quietly going on all around us every day.

It is, perhaps, precisely because these organizations are so much a part of daily life that we often have taken them for granted. Their research vessels are common sights on our waterways. Their facilities are familiar landmarks. Their employees are our friends and neighbors.

Worthy Work

Whatever their individual missions and means, MSEP organizations share the common philosophy that they exist solely to serve the public.

Their laboratories and offices are vibrant places where the lights are on 24 hours a day. With commitment and conviction they can make a difference, high-energy people go about their business with a sense of urgency. They know their work can save and restore natural resources. It can save livelihoods. And, in the hunt for such breakthroughs as new medicines from marine organisms or precise predictions of storm surges, it can save lives.

Although often unheralded locally, many of Carteret County's own are internationally renowned for their discoveries and accomplishments. With or without public recognition, scientists in these laboratories and on area waters, day by day, strengthen and broaden the cumulative foundation of knowledge. The experienced work side-by-side with the generations to follow, graduate students and other young scholars who bring new questions and new perspectives to complex issues.

No less valuable are the organizations closest to the public. The museum and the aquarium have inspired millions of visitors over the years with the wonder and worth of our coasts and oceans. To touch a living sand dollar, to find a hermit crab in a whelk shell, to see a sea turtle swimming by an observation window – these are unforgettable experiences that empower ordinary people to get involved in coastal issues, though many live far from our shores. These encounters also leave lasting imprints on our children, who someday soon will become the decision-makers.

As the 21st century advances, all these programs are becoming ever more imperative. In its report earlier this year, the U.S. Commission on Ocean Policy urged our country's leaders to make marine science research and education a national priority. Intensifying these efforts, the commission concluded, is the only hope for the future of attractive beaches, clean and safe waters, prosperous ports, responsible development, sustainable fisheries and, indeed, the health of the seas themselves, upon which all life on Earth depends. Carteret County's MSEP organizations will likely be important players in that initiative.

The economists who conducted the analysis talked about MSEP as a marine science cluster. The organizations, taken together, may well fit some definitions of that business term. But in a social sense, they are a community. The partnerships, collaborations and cooperative efforts are far too numerous to list. Sometimes these are formal arrangements among institutions. Often, though, they arise simply from colleagues talking to colleagues, friends calling on friends.

Each organization also is a part of the larger Carteret County community. They generously share their expertise and their resources with area schools. They open their conference rooms for meetings and gatherings. While their workplaces bolster our economy, their employees and their families enrich our lives culturally and socially.

And together with the Economic Development Council, the Partnership is lighting the way for businesses and entrepreneurs to bring more jobs and benefits to Carteret County, in this vitally important field of marine science.

I hope you enjoy reading the economic analysis results and the stories of the partnership members. I also hope they inspire you as they did all of us involved in this effort.

Dave Inscoe
Executive Director
Carteret County Economic Development Council

The Carteret County Economic Development Council, Inc. is a non-profit membership organization incorporated in 1971 to promote the economic welfare of Carteret County. Led by Executive Director Dave Inscoe, the primary goals of the EDC are to generate additional job opportunities in Carteret County, and to expand the tax base of the county and its municipalities through planned, quality growth. The EDC provides assistance to entrepreneurs and existing or expanding businesses, as well as prospective companies considering Carteret County for a relocation or expansion. A public-private partnership, the council is funded primarily by Carteret County through annual appropriations. In addition, for the past 30 years, representatives of member businesses have provided financial support and volunteer time to assist the efforts of the EDC in creating new economic opportunities in Carteret County.

For information on the partnership or the council, contact:

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Published by the Carteret County Economic Development Council.
Printed by the Carteret County News-Times.
Compiled and edited by Julie Powers.

Introducing the Marine Science and Education Partnership

For more than 100 years, the study of marine science has been part of life in Carteret County, and Carteret County has been an important player in marine research, nationally and internationally.

We, the members of the Marine Science and Education Partnership (MSEP), are a coalition of directors of marine science institutions and agencies, and other concerned Carteret County leaders. We undertook to quantify our combined efforts in Carteret County so we could identify and enhance opportunities for the future.

We commissioned an independent economic analysis to examine these issues. We present the findings here, on pages 12 and 13, with great optimism. As a way of introducing or reintroducing ourselves, we also include profiles of member institutions that portray our work, our strengths and our philosophies.

Members currently represent nine marine science and education operations in Carteret County. We look forward to welcoming into the Partnership more organizations that share our vision.

The group first convened in 2002 at the invitation of Dave Inscoe, the executive director of the Carteret County Economic Development Council, who now serves as MSEP facilitator. Members met regularly for a year to discuss roles and impacts of our universities and agencies on the community, and how we could work together for the greater good both of our programs and Carteret County. When we formalized into the Marine Science and Education Partnership in 2003, we established these goals:

- To coordinate the efforts of individuals and institutions involved in marine science and education in Carteret County.
- To cooperate in the development and use of facilities to promote marine science and education in Carteret County.
- To use science, technology and education to enhance the climate for marine-related businesses and industry in Carteret County.
- To promote public education regarding, and involvement in, issues of environment and development in coastal and marine areas.
- To assist citizens and public and private sector institutions in efficient, effective planning and management of the natural resources of coastal and marine environments.
- To educate the business community on economic and social impacts of the marine science and education community in Carteret County.
- To promote the education of local, state and national governmental officials regarding the joint accomplishments of the marine science and education efforts in Carteret County.
- To promote the value of marine science and education to the citizens of North Carolina.

Marine Science and Education Partnership Member Institutions

Carteret Community College, Aquaculture Program
Duke University Marine Laboratory, Nicholas School of the Environment and Earth Sciences
National Oceanic and Atmospheric Administration, Center for Coastal Fisheries and Habitat Research
N.C. Aquarium at Pine Knoll Shores
N.C. Division of Marine Fisheries
N.C. Maritime Museum
N.C. Sea Grant
N.C. State University Center for Marine Sciences and Technology
University of North Carolina at Chapel Hill Institute of Marine Sciences

"The Marine Science and Education Partnership contributes $127 million and 3,162 jobs to the Carteret County Economy."
– 2004 Economic Analysis

"Having assessed its current status, the challenge before MSEP and the Economic Development Council is to capitalize on the economic development potential this study revealed."
– 2004 Economic Analysis

"MSEP members employ 401 people in Carteret County with a 2003 payroll of $17 million."
– 2004 Economic Analysis

"If MSEP were a single entity, it would likely rank among the largest, most diverse, and most comprehensive of marine research complexes in the US."
– 2004 Economic Analysis

Marine Science and Education Partnership Founding Members

Mr. Jay Barnes, Director, N.C. Aquarium
Dr. Joe Barwick, President, Carteret Community College
Mr. Doug Brady, Developer
Dr. David Green, Director, N.C. State University Center for Marine Sciences and Technology
Mr. Dave Inscoe, Executive Director, Carteret County Economic Development Council
Dr. David Johnson, Director, National Oceanic and Atmospheric Administration Center for Coastal Fisheries and Habitat Research
Mr. Gary Mercer, Mercer Building Company
Dr. David Nateman, Director, N.C. Maritime Museum
Dr. Mike Orbach, Director, Duke University Marine Laboratory, Nicholas School of the Environment and Earth Sciences
Mr. Preston Pate, Director, N.C. Division of Marine Fisheries
Mr. Lockwood Phillips, General Manager and Co-publisher, Carteret County News-Times
Dr. John Wells, Director, University of North Carolina at Chapel Hill Institute of Marine Science
Mr. Bob Hines, Fisheries Specialist, North Carolina Sea Grant

MSEP Economic Analysis Executive Summary Pages12-13

Areas of Expertise

Like the sounds and waterways of the North Carolina coast itself, the expertise of MSEP personnel is broad, diverse and fertile. They represent a broad range of expertise in the coastal and marine sciences, as well as in development policy, regulations, and resource management, including:

- environmental toxicology and marine biochemistry
- water quality and contaminants testing
- ocean floor imaging and mapping
- marine and estuarine biology and ecology
- fisheries ecology and management
- marine biotechnology
- coastal marine policy and management.
- marine veterinary medicine
- marine earth and atmospheric sciences
- advanced technologies and models in marine meteorology
- satellite oceanography
- coastal geophysical dynamics and computer visualization
- marine biotelemetry
- estuarine plume, inlet and barrier island dynamics
- mariculture and aquaculture, and enhancement of shellfish and finfish stocks
- seafood science, processing and packaging
- marine clinical medicine, pathology, and epidemiology and toxicology
- coastal and marine engineering and mineralogy
- marine and fisheries habitat protection and remediation
- growth, and reproduction of living marine resources
- wetlands conservation and restoration
- coastal development impact assessment
- marine archaeology

– From 2004 Economic Analysis

CARTERET COMMUNITY COLLEGE

Aquaculture Technology Program

CCC Aquaculture Program Grows a New Perspective on Seafood Production

MOREHEAD CITY – The new Aquaculture Technology Program at Carteret Community College (CCC) cultivates clams, oysters, flounder - and optimism.

As traditional fishing is beset by declining domestic stocks and increased imports, aquaculture could mean a new outlook for fishing families who can no longer depend on nature alone for their livelihoods.

CCC student John Davis, from the small Down East village of Davis, knows the realities all too well. He comes from a family long involved in seafood and commercial fishing.

"There's not a big future in that anymore," he says.

But the courses on how to produce fish, shellfish and crustaceans under controlled conditions, launched in 2001, have brighter prospects. The first Associate of Applied Science degree in aquaculture was awarded in May. A full-time coordinator went to work in February. This fall, the expanded curriculum will move from a rusting old menhaden net house to remodeled quarters in the modern Robert Howard building.

> ***"We are hopeful that through this program, entrepreneurs and others may learn even more ways to be successful using some of the techniques taught here..."***
> ***Joe Barwick***

Penny Hooper, CCC biology coordinator, guided the aquaculture program through its first year. "I'm passionate about it," she says. "It's a good way for people to still work the water and be employed in a fishery, without having to count on the wild stock."

Aquaculture doesn't necessarily replace traditional harvesting, she says. But it can be "an ace in the hole" for the small producer in an unpredictable business. Hooper speaks from experience. Her husband, Mark Hooper, has for years cultivated shellfish in addition to commercial fishing.

"We've seen it work in our lives," she says.

Whether as a supplement to traditional methods or stand-alone enterprises, aquaculture is rapidly gaining momentum in the seafood industry worldwide, increasing as much as 10 percent every year. In North Carolina, farm-raised fish and shellfish amount to at least $15 million in sales annually.

"With opportunities already for employment, aquaculture looks very promising," says Joe Barwick, president of the college. "We are hopeful that through this program, entrepreneurs and others may learn even more ways to be successful using some of the techniques taught here."

Colleges Cooperate

Aquaculture's appeal isn't limited to those with fishing boats in their backgrounds. The first graduate of CCC's two-year Associate in Applied Science (AAS) degree program, Lewis Shields, is a retired banking equipment repairman.

His degree actually came through Brunswick Community College, which has a well-established program and an admirable facility, the Center for Aquaculture Technology. Taking advantage of Brunswick's resources and experience, CCC collaborated with the southern campus to launch its program.

The arrangement also gives students at both colleges exposure to different types of aquaculture. Brunswick emphasizes popular farm-raised freshwater finfish such as yellow perch, catfish and hybrid striped bass. CCC's curriculum is one of few in the nation to focus on mariculture - growing saltwater species including shellfish, crustaceans, and, of late, marine finfish.

Lecture courses from Brunswick have been taught via distance-learning classrooms. Field trips and practicums give students at both colleges experience with marine and freshwater components. CCC students also work with local producers in internships.

CCC students can attain three levels of expertise, with time investments ranging from one semester to the AAS degree. Under a "2+2" agreement with the University of North Carolina at Wilmington, qualified AAS graduates can enroll in UNCW's marine biology program as juniors. The credits also are transferable to most other four-year universities. CCC is working toward awarding AAS degrees in its own name in the near future.

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Established: 2001
Aquaculture Staff: 2
Mission: Carteret Community College will be a leader in improving the quality of life for all citizens of Carteret County and Eastern North Carolina by offering high-quality, innovative education, training, enrichment and support to all who need and value these services.

Options Offered:
Aquaculture Certificate - Part-time program, 13 semester hours
Aquaculture Diploma - Full-time, one-year program
Associate in Applied Science - Full-time, two-year program; college transfer curriculum, 2+2 agreement with University of North Carolina at Wilmington.

Mariculture seemed a natural match for the community college's mission to prepare students for a changing workforce, and for its waterfront campus overlooking Bogue Sound. A CCC public survey in 2000 concluded, among other things, that the county needed more water-based jobs and alternatives to fishing. CCC's response was two-fold: The Marine Trades and Education Center nearing completion, and the Aquaculture Technology Program.

Hooper collaborated with Philip "Skip" Kemp on an N.C. Sea Grant Fisheries Resource Grant to convert the menhaden building into a demonstration mariculture lab. Kemp at the time worked with aquaculture and mariculture at the N. C. Sea Grant marine extension office, based at N.C. State University (NCSU) Center for Marine Sciences and Technology on the CCC campus. Earlier this year, Kemp left Sea Grant to become the aquaculture curriculum coordinator at CCC.

> ***"This is what I want to do, start a flounder business. And I'm seeing it right here..."***
> ***Matthew Penny***

Students learn the skills necessary to launch, manage or work in aquaculture operations, and to work in aquariums, hatcheries, water gardens and natural resources agencies.

"It's applied marine biology," Kemp says.

The courses cover how to build tanks, plumb the seawater systems, maintain the correct temperature, chemistry and water quality, manage spawning for maximum procreation, diagnose and treat disease, and otherwise keep the product prolific, healthy and growing until market.

Students also learn how to produce fish food as well as the fish. Flounder, the program's first try at finfish, are grown out on a hand-mixed blend of cornmeal, soybean meal and fishmeal.

The latest entry into the age-old fishing profession might benefit a once-thriving segment now in decline. Fishmeal is made largely from menhaden, a small, oily fish species once unloaded by the ton on the same grounds where the mariculture program is blossoming. Plants that processed menhaden into oil and fishmeal for decades were a common sight on local waterfronts. As demand diminished, all but one in Carteret County disappeared. Aquaculture, however, could revive the market for menhaden.

"It may be that the survival of our local menhaden fishmeal industry is linked with the growth of aquaculture," Kemp says.

Kemp hopes to add more saltwater finfish such as black sea bass and tripletail to the finfish demonstration projects. "They're species that have a lot of potential for aquaculture because of their growth rates, because of their flavor, because of their apparent ease of domestication," he says.

Long-term Benefits

Projects involving shedding crabs and cultivating clams and oysters remain part of the curriculum. Kemp also teaches a continuing education course in "oyster gardening," after a successful pilot program last year.

Growing oysters in small private shoreline gardens for personal consumption, or in mariculture operations, could be a bonus for North Carolina's native stock, Kemp says. Pollution, overharvesting, parasites and disease have greatly diminished oyster numbers.

CCC's new mariculture lab will have the capacity to become a major oyster hatchery. Last year, rudimentary facilities produced 60,000 oysters, already attached to old shells and ready for transplant.

> ***"It's a good way for people to still work the water and be employed in a fishery, without having to count on the wild stock....."***
> ***Penny Hooper***

Combined with other actions to reverse the damage, Kemp says such efforts could renew North Carolina's oyster population. In other states, oysters seeded in one area have increased spawning in surrounding waters.

"It's possible, when you consider that in just a single spawning episode in the lab, we can produce 200 million oyster larvae," he says. "Just think if we did that repeatedly." Restoring oysters to their old habitats has far-reaching effects beyond the market or the dinner table.

"They're purifying the water, and adding to fisheries habitat, so we have more shrimp and crabs," Kemp says. Other shellfish such as clams also are natural water cleansers.

Long-term effects such as these could be another plus to the commercial fishing industry.

"If we can improve our own domestic production and supplies, we'll be enhancing valuable natural resources," Kemp says.

Meanwhile, students are seeing more immediate results.

Matthew Penny of Angier says he was nearly finished with the requirements for a degree in coastal and marine resource management at NCSU when he enrolled at CCC in December. He plans to graduate from NCSU while he continues taking aquaculture classes. He sees his future in the tanks of tiny flounder in the mariculture lab.

"This is what I want to do, start a flounder business," he says. "And I'm doing it right here. I'm doing it right here."

Nicholas School of the Environment and Earth Sciences

DUKE UNIVERSITY MARINE LABORATORY

Duke University Marine Laboratory Brings Conservation Close to Home

PIVERS ISLAND - With conservation at the heart of more and more of its programs, Duke University Marine Laboratory (DUML) practices what it teaches. The complex itself is a lesson in environmental stewardship.

DUML's planned Ocean Science Teaching Center will be a "green" structure, designed to use nature - sunshine, wind, rain – while having little impact on it. Solar heating was added to the dormitories during remodeling last year. Future new buildings and renovations also will be developed in accord with the environment.

"We are very specifically focused on conservation, on coastal and marine conservation," says Mike Orbach, marine laboratory director. "We like to think that our academics, our physical facilities and our research are all trending in the same direction – taking science and making a difference with it."

> ***"We emphasize that you can do good environmental work from a wide variety of platforms..."***
> ***Mike Orbach***

Science at DUML includes social science. The theme of this year's undergraduate second summer term is conservation, biology and policy. Duke's is perhaps the only university marine laboratory in the nation with social scientists on the faculty alongside biologists, zoologists, oceanographers and others from traditional marine sciences disciplines. Orbach himself is an economist and a cultural anthropologist.

"We have very consciously gone in the direction of being very broadly interdisciplinary in the natural and social sciences," Orbach says. "We're all very active in the real world of policy, and human behavioral change to achieve conservation and the goals of sustainability."

Established in 1938, DUML became an important component of the Duke University Nicholas School of the Environment and Earth Sciences when the school was created in 1991.

DUML has a full-time resident faculty and a full academic program year-round for undergraduates as well as masters and doctoral students, which also sets it apart from other marine laboratories. Orbach describes the Pivers Island complex as a "mini-campus," with dormitories, a dining hall and a student center.

Since becoming director in 1998, Orbach has been reorganizing the use of structures that had been built at different times with little order to their placement. Maintenance, administrative and social and residential areas have been clearly defined, as buildings were reassigned and remodeled.

"Now we're starting on serious renovation of the academic and research buildings," Orbach says. A new oceanography building was the first new structure in 30 years. The next phase involves replacing the three-story Bookhout building, the main laboratory built in the 1970s, with a lower-profile, environmentally friendly facility.

DUML also is using its setting to show that environmental sensitivity can be retroactive. In cooperation with its island neighbor, the National Atmospheric and Oceanic Administration marine laboratory, a 500-foot stretch of bulkhead was removed and a marsh restored.

"There are two messages there," Orbach says. "One, you don't have to have a vertical bulkhead, and two, if you have one, you can take it out." Duke and NOAA are working together on a plan to prevent storm water from flowing directly into adjacent waters.

DUML's surroundings are an advertisement for conservation, and for Carteret County. The island offers a vista of natural wonders, uninhabited islands and human history.

"When we stand out on the point there, and look out at Shackleford, the Rachel Carson reserve, the town of Beaufort, Fort Macon - there's no better view on the East Coast than that," Orbach says. "Everybody that comes here goes away with a pretty special appreciation of Carteret County as a place with a wonderful natural environment."

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

Duke University Marine Laboratory
Nicholas School of the Environment and Earth Sciences
135 Duke Marine Lab Road
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www.nicholas.duke.edu/marinelab

Established: 1938
Faculty and Staff: 71
Mission: Duke University Marine Laboratory's mission is education and research in the basic ocean processes, coastal environmental management, marine biotechnology and marine biomedicine.

Taking Science into Society

DUML's island complex has been part of the view from the Beaufort waterfront for decades. The Cape Hatteras, a 135-foot oceanographic research vessel that docks at DUML, is a prominent feature when in port. The National Science Foundation ship is operated by the Duke/University of North Carolina Oceanographic

Consortium.

The marine laboratory has a long history of natural sciences education at the undergraduate and Ph.D. levels. The largest single program at the laboratory now, however, is its professional masters program in coastal environmental management.

"Those are the people I call our translators, 'our save the world' people," Orbach says. They go on to work at government agencies, non-governmental organizations and even heavy industry.

"We emphasize that you can do good environmental work from a wide variety of platforms," he says.

Next year, a new faculty member in marine conservation technology, a joint professorship with Duke's engineering school, will be based at the DUML. The professorship will focus on applying and developing equipment that advances preservation and monitoring work, such as tagging devices that transmit data. It will be the first of its kind.

"We're going to create this specialty," Orbach says. A gift from Duke graduate and West Marine founder Randy Repass and his wife, Sally-Christine Rodgers, enabled the endowed professorship. The couple also made the lead gift toward the Ocean Science Teaching Center.

DUML is increasing its scope of marine science specialties as it continues its long-term research in estuarine ecology and invertebrate zoology. New areas include large "pelagics" – creatures that range wide in the world's oceans. DUML is working with Stanford University on a blue fin tuna study.

It also collaborates with its local counterparts on other projects such as "FerryMon." Researchers from DUML and the University of North Carolina at Chapel Hill Institute of Marine Sciences worked with the state to use state ferries crossing Pamlico Sound for water quality sampling.

The laboratory is expanding its work with "charismatic mega fauna" - endearing and imperiled animals such as dolphins, whales and sea turtles. A three-year project on the gender ratio of sea turtles just wrapped up.

The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) recently moved operations to DUML. The volunteer coalition of scientists and policy makers oversees the largest network of sea turtle conservation and research projects in the world. It coordinates efforts with the governments of 45 sovereign states and territories in the Caribbean region. Six of the world's seven species of sea turtles cross these national boundaries as they feed and nest. All six species are considered endangered; three critically so.

"Marine turtles are highly migratory, and this is the only way to have any reasonable assurance that they will survive the coming century," says WIDECAST executive director Karen Eckert, who has a doctorate in zoology and the equivalent of a master's degree in global policy studies. Founded in 1981, WIDECAST is a partner to the Caribbean effort of the United Nations Environment Programme.

WIDECAST maintains its independent status at DUML, but Eckert and her husband, Scott Eckert, WIDECAST's science director, are research scientists at DUML and teach classes on sea turtle biology. Both are internationally recognized for their work.

DUML was Eckert's first choice from among many East Coast universities that offered WIDECAST the institutional support it needed when it outgrew her California home office.

"There's a passion here for making science relevant," she says. "When you effectively wed the natural and social sciences, you get a synergism that creates the best possible conservation."

The Human Dimension

Lisa Campbell, the Rachel Carson Assistant Professor of Marine Affairs and Policy, is a human geographer who joined the faculty last fall. Campbell focuses on the importance of a diminishing resource to the local community and its economy, a consideration often omitted from environmental initiatives. Much of her work has been in developing countries.

She has researched a variety of sea turtle management approaches in Costa Rica, where sea turtles and their eggs historically have been an important source of food and income. Her goal is to learn more about the socio-economic role of the creatures, not the animals themselves.

"I study the people who interact with, value and use sea turtles," she says.

Conservation plans that work, she says, are the ones that involve and benefit the community as they protect the turtle population or other endangered species. Strategies that succeed in one community or with one resource may be ineffective in another.

"I think there's a real local context to all conservation, and so we need to understand that local context," she says.

She also is looking at how different interests use scientific data, and the gaps in it, to support their own preferences, perhaps subconsciously.

"At some point, there is an interpretation of that data, and that is where other things come into play – your value system; whether you think turtles are available only for 'ooh-ah' interactions, or if they are a legitimate source of protein."

Ultimately, she says, conservationists feel that increased understanding of the biology of natural systems, while crucial, by itself is not the key to successful, sustainable management of resources in decline.

"It's going to be economic, political and social institutions that are the real barriers to implementing effective conservation," she says. "The value is in furthering our understanding of those systems."

National Oceanic and Atmospheric Administration

Center for Coastal Fisheries and Habitat Research

Habitat, Fisheries at the Forefront in NOAA Lab's Second Century of Science

PIVERS ISLAND - In the stark underwater scene on the computer screen, a branch of gray staghorn coral seems to be the only sign of marine life - if, indeed, it is alive.

"There's a whole generation coming up that thinks this is what a reef should look like," says David Johnson, director of the Center for Coastal Fisheries and Habitat Research (CCFHR) near Beaufort.

> ***"We are planning for our next 105 years...."***
> ***David Johnson***

The next slide shows the same background, but seagrasses and sea urchins flourish in the sand, and many fish of varied size and color swim around the orange coral.

"This is how a healthy reef looks," Johnson says. "That many fish, that many species."

The center's aim is to assure that the second scenario – a vibrant and diverse marine community – is more common than the first. The National Oceanographic and Atmospheric Administration (NOAA) marine laboratory researches, monitors, protects and restores marine habitats such as coral reefs, seagrass beds, salt marshes, oyster beds and estuarine areas, and the fish and marine life that depend upon them.

The NOAA complex on Pivers Island has been a community landmark and an important federal marine laboratory since 1899, though its name, governing agencies and departments have varied. Since 1999, the laboratory has been one of five centers in the newly created National Centers for Coastal Ocean Science under the National Ocean Service.

In the laboratory's long history, its tasks have ranged widely, including propagating diamond-backed terrapins and assessing the effects of radiation on invertebrates.

Some of the multitude of its current habitat and fisheries projects take researchers to the other side of the world; some to their own backyard. The center collaborated with its only neighbor on Pivers Island, Duke University Marine Laboratory (DUML), to restore a marsh where a bulkhead had been.

With nets hung from the island's bridge, the center has been monitoring the movement of menhaden and other fish through Beaufort Inlet since 1985. The nets catch a representative sample of fish and larvae as the tide ebbs and flows between the inlet and the Newport River and its estuaries. The findings, combined with a similar data set in New Jersey, help scientists predict distribution throughout the year.

Continuing a long history of research critical to management decisions, fisheries researchers grow fish through their entire life cycle. Using that information and other techniques, they assess current fish stocks and predict future population numbers.

"Part of management is knowing how big the population is," Johnson says. "People here are providing that information."

The National Marine Fisheries Service component at the laboratory also conducts extensive research into marine mammals and sea turtles, and the effects of human activities on their populations.

The laboratory recently developed more aquaculture facilities for fisheries research, including a greenhouse that duplicates the native habitats of marine fish. Researchers are studying whether raising fish in a more natural environment, rather than in tanks, increases survival rates when released into nature, thereby also increasing the success of restocking efforts.

Ecosystem Stressors

CCFHR researchers have been studying the function, fragility and reconstruction of marine habitats for decades. A recent series of Congressional acts has made such work a national priority.

CCFHR scientists scrutinize how human activities and natural events stress these habitats and the larger marine ecosystems. By examining past and current conditions, they are increasingly able to predict - and when people cause the problem, perhaps change – the future of these complex and increasingly vulnerable webs of underwater life.

"Say a boat runs aground in the Florida Keys," Johnson says. "We provide the research and the protocol which allow people to assess how much damage was done and assign a monetary figure to it."

As North Carolinians well know, nature itself can render dramatic alterations. Just as forecasters could estimate how a hurricane's storm surge might affect coastal communities, CCFHR strives to predict what a specific hurricane will do to specific ecosystems. Concentrations of some fish species, for example, diminish after hurricanes with certain

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Established: 1899
Staff: 101 federal and contract
Mission: The mission of CCFHR is to provide the science needed to help managers understand and respond to ecosystem change in the coastal and marine environment.

characteristics, information useful to fisheries managers and commercial fishermen.

On a larger scale, NOAA is assembling a comprehensive ocean observation and forecasting system, using measurements of the physical characteristics of seawater and its movement.

"It will take much of the guesswork out of what is going on in the ocean," Johnson says. On an island and within sight of the sea, the center could be important in the system's development.

> ***"We focus on top-to-bottom science, basic research and detailed application for managers..."***
> ***Mark Fonseca***

CCFHR also researches invasive species that are disrupting ecosystems worldwide, including North Carolina. Paula Whitfield of CCFHR determined that lionfish, typically found in tropical oceans, have been thriving off the state's coast since 2000. The lionfish's venomous spines can inflict severe pain on divers or fishers in accidental encounters.

"In summer months, if there is a reproducing population offshore, we may get these fish inshore," Johnson says. Researchers are examining what conditions the fish favor and what their expanded range means to other species.

Climate change and resulting sea level rise are another ecosystem stressor under study. Some predictions say the water could be a foot or more higher within 50 years. On North Carolina's flat coast, a small increase can bring big changes; higher flood insurance rates among them.

"In addition, sea level rise will affect oyster beds and seagrass beds, which in turn will affect other species," Johnson says.

Pollution is a major contributor to harmful algal blooms that present problems for fish and shellfish or their food sources. Some toxic algae can cause human health problems.

Under the direction of Pat Tester, staff members sample the water and the algae when a bloom occurs to assess factors that caused it. They recently tested a new "Autonomous Underwater Vehicle," a self-powered device capable of documenting conditions in shallow estuarine waters, where blooms are especially problematic.

Molecular probes coded to specific organisms are among the latest tools in the difficult task of identifying algae. Using the probes, CCFHR biologist Mark Vandersea determined a common water mold likely causes many of the lesions on fish that were previously attributed to Pfiesteria, an alga subject to much debate. The mold apparently gets under fish skin through small sores or openings, and spreads throughout the tissues.

Restoration Groundwork

Some of its work is based in North Carolina, but CCFHR's focus is nationwide. It administers another laboratory at Kasitsna Bay near Seldovia, Alaska. University of Alaska-Fairbanks students and staff, state and federal researchers and students from high schools and other academic institutions use the laboratory.

CCFHR monitors and researches natural processes and interrelationships, human impacts and restoration efforts in marine sanctuaries and protected areas coastwide. Similar activities are underway in National Estuarine Research Reserves (NERR), which NOAA oversees.

In all its efforts, CCFHR intends its work to be translated into action.

"We focus on top-to-bottom science, basic research and detailed application for managers," says Mark Fonseca, a research ecologist.

Fonseca and his colleagues worked with the state of Florida on a pilot program to hold boaters financially accountable for injuring habitats when they run aground in marine sanctuaries. The program assessed boaters over $500,000 in restitution in the first year, Fonseca says, but that represents only a fraction of the damage.

"We've taken our knowledge of the recovery dynamics of each plant in the coral community, and used them to guide restoration and build a program that will only be successful if it's no longer needed," he says.

Researchers at CCFHR began to establish the ecological worth of marine habitats long before the federal protection initiatives of the last 15 years.

> ***"We really got the ball rolling in the '60s and '70s on salt marsh and seagrass research and the value of these habitats to fisheries ecology..."***
> ***Gordon Thayer***

"We really got the ball rolling in the '60s and '70s on salt marsh and seagrass research and the value of these habitats to fisheries ecology," says Gordon Thayer, CCFHR Deputy Director.

Researchers at the laboratory built the foundation for many of the restoration efforts now being implemented nationwide. Thayer himself played a lead role in establishing restoration guidance and syntheses, and laboratory staff members have been among the leading researchers in seagrass restoration approaches. Thayer conducted a symposium for scientists and federal legislators in 1989, and edited a significant reference book, *Restoring the Nation's Marine Environment,* that resulted. He also co-organized NOAA's Restoration Center, established soon after.

He is the senior author on Volume One of *Science-Based Restoration Monitoring of Coastal Habitats*, a recently completed guidance document on measuring the success of restoration efforts. Other CCFHR staff members, Thayer says, continue to play important roles in all of these restoration-related efforts. Fonseca and his team of researchers, for example, currently are developing models to predict the recovery of seagrasses and corals from natural and human impacts.

Research from this laboratory in Beaufort, the second oldest federal marine laboratory in the nation, is known for its staying power in many other areas, and there is more to come. Johnson is working with DUML on a master plan for Pivers Island.

That includes NOAA's first new building in 45 years. It will house a teaching laboratory, an auditorium and space for NERR state offices, among other things. The building is part of Johnson's modernization plan to better support center efforts at confronting the environmental challenges of today, and of the future.

"We are planning for our next 105 years," he says.

North Carolina Aquarium at Pine Knoll Shores

NC Aquarium at Pine Knoll Shores Will Make a Big Splash in 2006

PINE KNOLL SHORES - As its home of nearly 30 years is being remodeled, the N.C. Aquarium at Pine Knoll Shores is like a fish out of water.

But no one involved is complaining. In 2006, the state-operated aquarium will emerge from a $24 million renovation that will more than triple its space. The largest display tank before expansion held 12,000 gallons, compared to a 306,000-gallon ocean tank under construction. The number of full-time staff will go from 14 to about 40.

> ***"People come to have a good time and they end up appreciating and understanding the world around them a bit more...."***
> ***Jay Barnes***

"We're in this limbo between what we were and what we're going to be," says Jay Barnes, aquarium director. But, "we will have a world-class facility when we're done."

Before it closed, the aquarium was a must-see vacation attraction, drawing 250,000 visitors a year. The transformed version is expected to double that number. According to some projections, the new staff positions and increased visitation combined are likely to funnel $6 million annually into the regional economy.

The remodeling is aimed at furthering the mission shared by all three North Carolina aquariums -- to promote awareness, understanding, appreciation and conservation of the state's aquatic environments. Since it opened in 1976, the Pine Knoll Shores facility has educated millions - sometimes subtly – on those points. Children on class field trips accounted for many of the learners. Carteret Community College included aquarium visits in its marine biology curriculum. But other visitors weren't necessarily seeking knowledge.

"The public is fascinated by the ocean and its inhabitants," says Barnes. "We try to capitalize on that fascination and mesh it with the educational components. People come to have a good time and they end up appreciating and understanding the world around them a bit more."

When it reopens, the aquarium will spread over 93,000 square feet, compared to 29,000 square feet prior to remodeling, and will feature several new crowd-pleasing exhibits. The 306,000-gallon ocean tank will contain a replica of the German submarine, *U-352*, that sank off Cape Lookout in 1942. Divers will mingle with sea turtles, sand tiger sharks, moray eels and schools of fishes that commonly congregate around shipwrecks. All this will be visible from an observation window 60 feet long.

A 50,000-gallon tank will duplicate the underwater scene of the shipwreck thought to be Queen Anne's Revenge, again with a typical community of marine life. The flagship of Blackbeard's pirate fleet sank in Beaufort Inlet in 1718. Public excitement was fired when a 1996 diving expedition found timbers and artifacts near the inlet, dating back to the time the pirate vessel went down.

"These shipwrecks are an important part of our history here," Barnes says. "It just so happens they make incredible reefs." Also planned are a jellyfish gallery and a sportfishing exhibit.

The remodeled facility will represent a much bigger picture of aquatic habitats than previously. In addition to familiar saltwater creatures and settings, the 2,500 to 3,000 specimens of mammals, fish, reptiles and amphibians will illustrate aquatic habitats "from the mountains to the sea" in North Carolina.

Visitors will witness a river otter exhibit, a trout pool, a waterfall and other

The North Carolina Aquarium at Pine Knoll Shores
Atlantic Station Shopping Center (Temporary Offices)
Atlantic Beach, NC 28512
252-247-4003
www.ncaquariums.com

Established: 1976
Staff: Approximately 40 full-time positions when reopened
Visitation: Projected 500,000 annually when reopened
Mission: To foster a greater appreciation of North Carolina's aquatic life.
Accreditation: The N.C. Aquarium at Pine Knoll Shores and the other two state aquariums are accredited by the American Zoo and Aquarium Association.
Departmental Affiliation: The N.C. Aquarium at Pine Knoll Shores is one of three state aquariums operated by the N.C. Dept. of Environment and Natural Resources

Remodeling Highlights:
Tripled space, to 93,000 square feet
306,000-gallon ocean tank, observation window 60 feet long
2,500-3,000 aquatic specimens from the "mountains to the sea"

Architectural Drawing of Remodeled Aquarium

freshwater habitats from the mountains, the piedmont, the coastal plain, the coast and the ocean.

The popular touch tanks will be back and expanded, allowing visitors memorable personal contact with stingrays as well as crabs, invertebrates and other creatures.

Outdoor Programs

The aquarium will continue to use the habitats surrounding its Pine Knoll Shores building for environmental programs after the remodeling. The aquarium is located in the 295-acre state-owned Roosevelt Natural Area, which includes maritime forests, salt marshes, swamp forests, easy access to Bogue Sound and two nature trails wending through the different landscapes.

> ***These shipwrecks are an important part of our history here. It just so happens they make incredible reefs...."***
> ***Jay Barnes***

Canoe treks, field trips, marsh hikes, seining in the sound, clamming and crabbing classes, dredge and trawl trips, beach walks, night treks and other encounters with the coastal outdoors are popular programs.

"Those are all ways our visitors can get closer to the living environment," Barnes says. Although on a reduced schedule, many of these activities will continue from the aquarium's offsite location at Atlantic Station Shopping Center in Atlantic Beach throughout the renovation, thanks to the cooperation of other environmental education organizations.

A day camp for children was held for this summer, and the education staff will be leading school field trips or visiting classrooms with animals in hand as usual. Field trip registrations are handled at the aquarium's temporary quarters at the Atlantic Station Shopping Center.

Though primarily an educational and recreational attraction, the aquarium will add a conservation and research coordinator position in its newly expanded facility to work on staff-initiated and cooperative research projects.

Pine Knoll Shores is the last of the three state aquariums under the N.C. Dept. of Environment and Natural Resources to undergo a major overhaul. The Manteo aquarium unveiled its expansion in 2000, and Fort Fisher followed in 2002.

The Pine Knoll Shores facility was readying for its turn in 1999 when the aquatic environment interfered. Hurricane Floyd brought unprecedented flooding - and flood damage – to Eastern North Carolina in September of that year. The state diverted the $15 million in expansion funds to flood relief.

The N.C. Aquarium Society revived and improved the plans with a campaign to pay for the $24 million renovation underway. The society is a non-profit organization supporting all three state aquariums.

Looking Ahead

Throngs of beachgoers account for most of the visitor tally at Pine Knoll Shores, which totals as many as 3,000 on a summer day. In the future, visitation could see 5,000 to 6,000 in a day. But it has its loyal local following who visit year-round as well.

Elizabeth Brant, who grew up on Bogue Sound and lives along its shores today, was six years old when the aquarium opened as the N.C. Marine Resources Center. The name was changed in 1986.

"I thought it was the greatest place on earth," she says of her first visits with her fellow Brownie Scouts. "I've never lost my enthusiasm for it." Before it closed, she was a regular visitor with her family and the Girl Scout troop she now leads. A marine biology student at CCC, Brant has seen the other two aquariums since they were expanded, and is anticipating great things for Pine Knoll Shores.

> ***"I thought it was the greatest place on earth.... " Elizabeth Brant***

"I can't wait to see it in two years," she says.

Aquarium staff members have more than enough to keep them busy before the doors reopen. Their temporary quarters are being outfitted to hold specimens collected for the new facility. They are planning new exhibits and programs - and educating themselves on freshwater habitats.

"Our education staff and our husbandry staff will be getting up to speed on habitats and animals we don't know much about," says education curator Bob Patton. And, he says, staff members have hundreds of decisions to make. Although triple the space allows for many more exhibits and programs, no building can contain all the wonders of water and wildlife in North Carolina.

Director Barnes believes the renovated aquarium will be among the best in the nation, bringing its message to millions more.

"People are always looking for fun things to do with their families," he says. While they're having fun, the aquarium offers them a chance to pause and ponder the richness and variety of North Carolina's aquatic environment.

"That might happen when they see the beauty of a tropical fish or when an octopus changes color," Barnes says. "Or maybe when someone holds a horseshoe crab in their hands for the first time."

Executive Summary - Economic Analysis

Economic Impacts and Opportunities for Marine Science Research and Education in Carteret County, North Carolina

Center for Competitive Economics - Kenan Institute of Private Enterprise
University of North Carolina at Chapel Hill

August 2004

Carteret County is renowned for its beaches, its boating and the abundance of other recreational opportunities along its coastline. The coastline and its creeks, rivers and rich biological diversity also have attracted one of the largest concentrations of marine science research and education organizations in the nation. Yet, because these organizations have rarely been considered as a group, the magnitude of their activities has been largely overlooked.

In 2003, several of these institutions and agencies, along with the Carteret County Economic Development Council (EDC), formed the Marine Science and Education Partnership (MSEP) to explore common interests and opportunities.

The EDC, on behalf of the Partnership, contracted with the University of North Carolina's Office of Economic Development (OED) to document the economic impact of Partnership members in Carteret County and vicinity. The contract also called for an inventory of the marine sciences infrastructure within these organizations that could support and enhance a cluster of businesses related to marine sciences, therefore stimulating private investment and creating jobs.

The work revealed that the collective capabilities of MSEP are remarkable both in scale and in breadth. As a result, MSEP members have a significant direct and indirect beneficial impact on the Carteret County economy, a fact that until now has gone unnoticed because of the disaggregated relationship among organizations. Moreover, the study indicates that MSEP members possess physical and human resources with potential for even greater economic benefits to Carteret County, if these resources were better known.

MSEP Resources and Scale

The marine science resource base in Carteret County can be most appreciated when the organizations are viewed as a group. The OED compiled individual financial and organizational asset information gathered from MSEP partners to present a comprehensive economic overview and assessment.

During 2003, MSEP membership collectively accounted for:

- total revenues of $58 million, including $32 million in public grants and contracts, $21 million in government appropriations and $5 million in other support.
- total expenditures of $28 million, of which $20 million was expended directly within Carteret County
- total full-time employment of 487 jobs – 401 based in Carteret County – and a total Carteret County payroll of $17 million

The physical infrastructure of MSEP members includes both general and specialized research and development facilities accommodating a wide range of scientific investigations:

- 162,645 s.f. of marine research facilities, including more than 40 individual laboratories, several large flexible-use laboratories and numerous specialty facilities, including a seafood pilot plant, molecular biology laboratories, biotelemetry labs, analytical laboratories and marine biotechnology wet labs
- 117,000 s.f. of museum and aquarium facilities that hosted over 405,000 visitors annually in previous years. Both attractions are expanding, which will increase both their size and visitation.
- a research fleet for the conduct of coastal and off-shore investigations that includes four major research vessels and more than 40 smaller craft

MSEP research and technical personnel comprise a broad and diverse pool of expertise in a variety of disciplines, ranging from coastal environmental management and integrated marine conservation to aquatic food products, oceanography, marine biology, marine biomedicine and marine biotechnology. The MSEP research team includes:

- 62 faculty and non-faculty researchers
- 248 technical and professional staff
- 58 post-doctoral, graduate and undergraduate research assistants
- 119 administrative and support personnel

The depth and breadth of scientific and technical expertise within MSEP is reflected in the success of the Partnership's faculty and staff in securing competitive funding, and publishing their research results. During 2003, MSEP members:

- managed 133 supported research projects worth $25 million
- submitted an additional 78 research proposals for $14 million
- produced 136 publications and papers
- enrolled 218 full-time graduate and undergraduate students

MSEP Economic Impact

The activities of the MSEP partners account for a substantial contribution to the economy of Carteret County. OED reported the estimated direct, indirect, and induced impacts of the MSEP organizations using two software/data services, IMPLAN and REMI. The services use input-output models to capture economic activity effects resulting from the creation and operation of MSEP organizations. The implicit assumption is that the direct, indirect, and induced spending attributable to MSEP programs would not otherwise have occurred in their absence.

- "existing" effects refer to actual employment and expenditures by MSEP partners
- "direct" effects refer to the direct changes in local demand resulting from the location of MSEP organizations in Carteret County
- "indirect" effects are from rounds of spending by companies supplying goods and services to MSEP organizations
- "induced" effects are generated by MSEP workers who otherwise would not be in the labor force in the target region

OED quantified the activities and infrastructures for member organizations to assess the economic impact of MSEP. Financial and employment information solicited from MSEP members was compiled to provide the basis for establishing MSEP's contribution to the economy of Carteret County.

This OED analysis found that MSEP's combined estimated economic impact in Carteret County (Exhibit 1) accounted for:

- a total of 3,162 j obs – nearly 1 out of 10 jobs in the county
- $127 million in economic output within Carteret County – more than 8 percent of the county economy

(See Exhibit 1 below)

Capitalizing On MSEP Collaboration Opportunities

Individually, each of the MSEP organizations is engaged in significant activities serving its primary mission. As active citizens of Carteret County's compact geographic area, the leadership and staff of the respective institutions have long been aware of the function and capabilities of the other organizations.

Each of the individual MSEP organizations

Significant Findings

During 2003, MSEP membership collectively accounted for:
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- total expenditures of $28 million
- total full-time employment of 487 jobs

The OED analysis found that MSEP's combined economic impact accounted for:
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- More than 8 percent of the county economy

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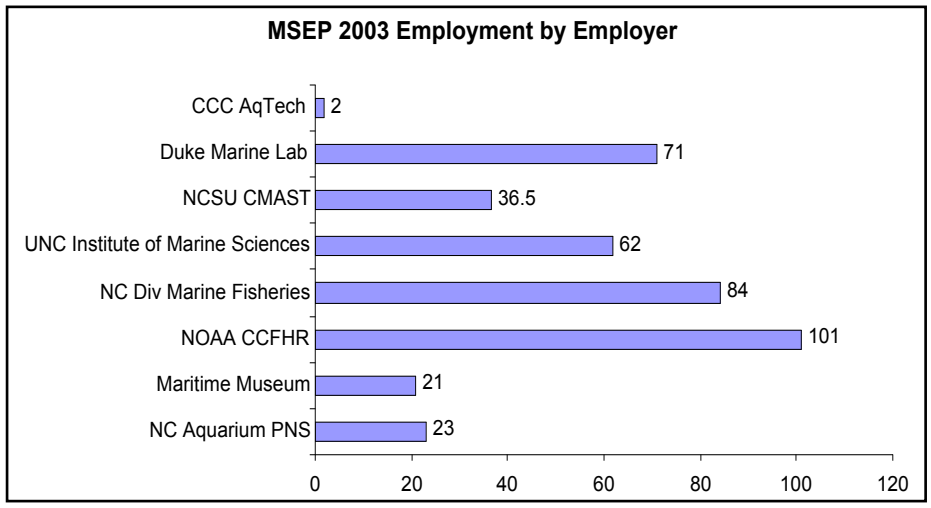
The physical infrastructure of MSEP members includes:
- 162,645 s.f. of marine research facilities, including more than 40 individual laboratories
- 117,000 s.f. of museum and aquarium facilities that hosted over 405,000 visitors annually
- a research comprised of four major research vessels and more than 40 smaller powercraft

Exhibit 1: MSEP Total Impacts in Carteret County (8 orgs)*

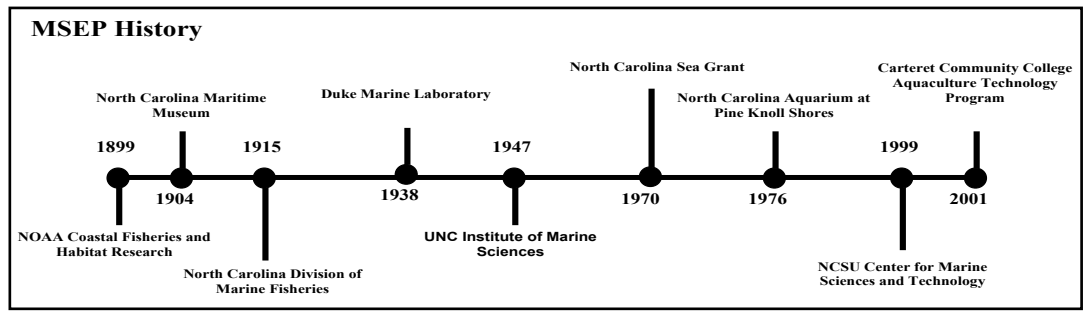
	Existing	Direct	Indirect	Induced	Total
Labor Income	**$16,686,950**	**$33,067,952**	**$4,477,087**	**$6,470,073**	**$60,702,062**
Employment	**401**	**2263**	**183**	**315**	**3,162**
Output		**$93,954,917**	**$13,766,594**	**$19,181,636**	**126,903,147**



possesses significant resources relevant to economic development. Efficient collaboration, aided by the fact that these institutions are concentrated in a relatively small area, can effectively integrate those resources.

Collaborative relationships within the local marine science community have grown in number in recent years. This increasing interactivity, along with recent facility expansions and institutional additions, stimulated interest in capitalizing upon mutually beneficial inter-institutional synergies. OED discussions with MSEP leaders suggest several areas of potential collaboration for further elaboration:

- ***Inter-institutional research proposals:*** The multi-institutional nature of MSEP's infrastructure and research resources suggests that collaborations would enhance the competitiveness of research funding proposals. A number of such joint proposals have been undertaken over the years, and discussions with MSEP researchers suggest receptiveness to increasing the number of cooperative approaches.
- ***Personnel recruitment and retention:*** Continued attraction of high-quality researchers and staff is critical to the vitality of MSEP. Several administrators cited their use of the diverse marine science community in Carteret County as a significant asset in the recruitment of key personnel.
- ***Marine science meeting co-sponsorships:*** Numerous marine science meetings and conferences occur regionally, nationally and internationally. Proactive collaborative hosting of such meetings at MSEP institutions would enhance the region's profile in scientific and industrial markets, while providing additional economic development benefits to the County.
- ***Marine and coastal policy research, analysis and development:*** A noteworthy aspect of MSEP membership is the proximity and communication between marine research institutions and state/national marine and coastal regulatory organizations. Increasing development pressures on coastal environments and communities creates an impetus for MSEP initiatives in collaborative coastal management research and policy development efforts.
- ***Marine Animal Veterinary Medicine:*** The N. C. State University (NCSU) College of Veterinary Medicine, which has faculty stationed at NCSU's Center for Marine Sciences and Technology (CMAST), is nationally known for its expertise in marine animal medicine. The initial collaboration between the N.C. Aquarium at Pine Knoll Shores and the NCSU veterinary school could be further developed to take full advantage of the pending specimen expansion of the new aquarium facilities.
- ***Valued-added marine products:*** Successful past and current collaborations between MSEP organizations in areas such as oyster hybridization, shellfish/finfish aquaculture, seafood processing and marine organism extracts, suggest potential for expansion, particularly in direct interaction among MSEP partners and private industry and entrepreneurs.
- **High-impact tourism:** Well-established tourism assets could be enhanced through interaction with MSEP partners to augment existing attractions with educational programs in the environment, marine biology, wetland conservation and advanced diving expertise.
- ***Beach renourishment/preservation practices and technologies:*** This thriving area of commercial interest could provide numerous opportunities for MSEP expertise on coastal management, near shore geology and sonar imaging instrumentation.



Carteret's Marine Cluster Challenge

Having assessed its current status, the challenge before MSEP and the Economic Development Council is to capitalize on the economic development potential this study revealed.

To do so will require a sustained cluster-building strategy targeted to marine education and research enterprises. Such an effort will require a management stewardship group, whether a new or existing organization, to spearhead and oversee the initiative. This cluster management organization must deliver services to cluster members, and provide the glue that keeps the cluster together.

A key element for success is communication. Strong formal and informal communications linkages show participants how their bottom-line interests are served by the cluster. Connections within the organizations of the Marine Science and Education Partnership, and between MSEP, Carteret County and the rest of the world must be established and maintained.

The power of networks brings like-minded organizations together on projects that can inspire them and spawn new ideas. MSEP members already are discovering the synergies of having similar and complementary missions but different contacts, resources and information networks. When the various networks are networked, the principals save time, benefit from a greater range of knowledge and techniques, and stay focused on the enterprise at hand.

Following the example of other areas in organizing clusters, some specific ways MSEP could begin to turn its information-sharing roundtables into a focused cluster-building effort are:

- cataloguing the key components of the cluster, including existing private enterprises
- articulating an achievable vision of what the cluster can become over the next 10 to 20 years, and
- identifying specific opportunities for growing the cluster and realizing greater synergies

Some of the returns that marine sciences firms in the Carteret County area might see from participating in a cluster-focused effort include:

- finding new markets or suppliers through the many contacts of MSEP members
- working with the universities and Carteret Community College to shape training curricula to the workforce required
- learning from the university and federal labs about new technology applications or research findings that could increase productivity or profitability
- using the specialized facilities of MSEP partners for product or process testing and/or joint projects; and
- increasing their political power to affect policy and competitiveness

One appeal of a cluster approach is that the particular strategies and required benefits can be determined and tailored by the participating organizations, depending on their markets, capacities and interests. In a cluster where technology advances are rapid, the firms may easily see the benefit of combining their knowledge to compete in a changing market.

If Carteret County can support cluster strategies that provide tangible benefits to the bottom lines of local companies, the value of MSEP will be more readily appreciated.

The Future

It is apparent from this study that Carteret County has a wealth of marine science operations, holding promise for both the scientific community and the county economy.

Each MSEP institution has significant assets and conducts a variety of activities that can contribute to economic development in a multitude of ways. By combining the advantage of geographic proximity with efficient collaboration, the Partnership can achieve an effective integration of its collective resources. The result could be additional meaningful benefits to the scientific community, and to the people of Carteret County.

Research Vessels

A distinctive and indispensable category of physical assets for marine research is ships and boats for the conduct of near-shore and off-shore investigations. The breadth of marine research conducted by MSEP is well supported by a diverse array of vessels. Collectively, the Partnership's research "fleet" is comprised of more than 40 mid-size power craft and four major coastal and research vessels:

- the *R.V. Cape Hatteras,* a 135-ft. oceanographic ship operated for the National Science Foundation by the Duke/UNC Oceanographic Consortium
- the *R.V. Susan Hudson, 57* feet, Duke
- the *R.V. Capricorn*, *47* feet, UNC-IMS
- the *S.F. Hildebrand*, 41 feet, NOAA

North Carolina Division of Marine Fisheries

N.C. Division of Marine Fisheries Seeks a Good Catch for All

MOREHEAD CITY - A trawler heading into port or a vacationer dropping a line off a pier are common coastal scenes, deceptive in their serenity. For business or pleasure, saltwater fishing in North Carolina occurs against a complex backdrop of legislation, conservation, economics, demographics - and mathematics.

The N.C. Division of Marine Fisheries (DMF) has the difficult task of balancing the demands of a growing coastal population against limited fish stocks. The division's mission is to ensure sustainable marine and estuarine fisheries for the benefit of all the people of North Carolina.

> ***"The challenge to us and all involved is that as the number of participants increases, expectations increase...:"***
> ***Preston Pate***

"That's a very simple statement that embodies a lot of complex processes and issues," says Preston Pate, division director.

Part of the N.C. Dept. of Environment and Natural Resources, DMF and its rule-making body, the nine-member Marine Fisheries Commission, have jurisdiction over saltwater fishing and shellfishing in all coastal waters, extending three miles offshore. That includes 4,000 miles of coastal shorelines and 2.5 million acres of estuarine and marine waters. An estimated 5,000 full-time commercial fishermen work these waters; 1.7 million recreational anglers fish them for fun. Both groups account for a big part of coastal North Carolina's economic base.

Managing important fisheries is by no means a new concept. The 1822 state legislature voted to impose restrictions on oyster harvesting gear, and subsequent regulatory actions led to the formation of the division's predecessors.

More recently, the General Assembly passed the Fisheries Reform Act of 1997. The sweeping legislation restructured commercial licensing, required comprehensive fisheries management and habitat protection plans and mandated more public involvement in policy making. Advisory committees representing a broad spectrum of interests now participate in the planning process.

Including many more people predictably slows the pace, Pate says.

"But it's necessary, and it's very healthy for us because of the increased stakeholder involvement, and the exposure to the public of what our ideas are during the formation of those plans," he says.

Changing Times

For the most part, the legislated requirements have been satisfied.

"I think, and certainly hope, we've met everybody's expectations," says Pate, who became director about the same time the act became law. Time will tell whether the reforms will have the desired results.

"On a macro level, the implementation of the act has been successful," he says. "The outcome of that imple-

The North Carolina Division of Marine Fisheries

3441 Arendell Street
Morehead City, NC 28557
252-726-7021
www.ncfisheries.net

Established: Beginnings date back to 1822 regulatory legislation.
Staff: 84 in Morehead City; nine sections, five district offices in addition to Morehead City headquarters.
Mission: The N.C. Division of Marine Fisheries is responsible for the stewardship of the state's marine and estuarine resources. Its mission is to ensure sustainable marine and estuarine fisheries for the benefit of all the people of North Carolina.
Departmental Affiliation: The N.C. Division of Marine Fisheries is a division of the N.C. Dept. of Environment and Natural Resources.

mentation and the effects on the resources are less obvious because they take a longer time to manifest themselves."

Recovery plans are in place for several species that are considered overfished, such as river herring and, along the central and southern coast, striped bass. Red drum, now listed as "recovering" in the latest stock status report, and blue crab, listed as "concerned" also have benefited from management plans.

"Once they're recovered, then they will be managed in such a way that the population will stabilize at a healthy and sustainable level for both commercial and recreational uses," Pate says.

The division also works with regional and national fisheries commissions on programs for commercially important species that migrate across state boundaries. Summer flounder, weakfish and striped bass in the Albemarle Sound were the focus of successful regional programs.

Recovery of a depleted stock, however, brings yet more management questions.

"When you raise the population levels of striped bass in Albemarle Sound, for example," Pate says, "what does that do to white perch, largemouth bass, yellow perch and other species, sought after recreationally and commercially, that are either eaten by striped bass or compete with striped bass for the same food source?"

"There's more awareness now that we have to manage these stocks on an ecosystem basis," he says. "You can't, on an individual basis, expect to maintain every population of fish at its highest level, because you've got predators and prey."

In the early 1990s, DMF actions at times displeased both commercial and recreational interests, which led to heated public disputes. The contention has noticeably lessened since 1997. Some people attribute that to Pate's leadership; he deflects credit to the implementation of the reform act.

> ***"It would be real easy to make certain species off-limits to certain segments. But that's the easy way out..."***
> ***Jimmy Johnson***

In all major decisions, the division and the Marine Fisheries Commission deal with issues that mean a great deal of money to a great number of people. Though commercial fishing is in a downturn, beleaguered by a number of troubles, it is still a mainstay in the coastal economy.

"The commercial fisheries have well documented economic benefits, not only the dockside value of the landings, but the expansion factor that goes beyond that dockside value," Pate says. "That value sustains a lot of communities in the county. It sustains a lot of individuals within the communities."

Meanwhile, recreational fishing is growing "at an astounding rate," Pate says. Its economic contribution is rising proportionately. But so is competition with commercial interests, and with other recreational fishermen, for favored species such as flounder.

"The challenge to us and all involved is that as the number of participants increases, expectations increase," Pate says. "It's our charge to make sure that those types of economic values can be sustained for the future, providing successful fishing opportunities for all user groups."

The decline of commercial fishing and the related changes in coastal communities is troubling for an organization that has worked with North Carolina watermen for decades. Many fishermen have gone out of business. Those that still fish find more and more docks and seafood houses for their catch pushed aside by population growth and demand for waterfront property.

"I don't know if there's anything we can do to stop it," Pate says. "Some of that growth is inevitable and inexorable. We do recognize it, and to the extent we can have an effect on it or control it or at least consider it in our management decisions, we do."

Healthy Habitats

The reform act also dictated synchronized efforts to protect, enhance and restore habitats so critical to so many fish, especially in their early life stages. Ninety percent of the East Coast's commercially important species spend some part of their lives in estuaries, and North Carolina has some of the largest estuaries in the nation.

"That's why the habitat protection plan in progress is such an integral part of the Fisheries Reform Act," Pate says. "It's so important to the future." The law requires three state rule-making commissions - the Environmental Management Commission, Coastal Resources Commission and Marine Fisheries Commission - to develop a joint plan addressing habitat, water quality and related issues. Work on the plan is still underway.

DMF for years has had its own program for restoring oyster reefs by dumping tons of empty oyster shells in selected places, providing ideal conditions for oyster larvae looking for a place to attach. The division is now coordinating with the N.C. Coastal Federation, a non-profit conservation group, on several oyster reef restoration projects along the coast.

"It's a good working relationship," says Sarah King, the federation's habitat restoration specialist. "They also have an oyster shell recycling program that has been very helpful to us."

Oyster shells have become an important and scarce commodity in recent years. To increase the supply, DMF established shell drop-off sites for individuals and businesses, and it arranges for pick-up at community or church gatherings that produce a large volume of shells. The shells are aged to eliminate contaminants before they are barged to favorable sites.

> ***"Unfortunately, the actions we take are going to have an effect on people that they might not see as a benefit to them..."***
> ***Jimmy Johnson***

The division has a wide array of other responsibilities, including registering commercial vessels, setting size limits on fish, and licensing commercial fishermen, gear, seafood dealers, spotter planes, fishing piers, bait salesman, nonresident commercial vessels and sales of fish at fishing tournaments, among other things. It has its own enforcement branch, the Marine Patrol.

With the coast's large and diverse groups of fishing interests, no one expects the provisions of the Fisheries Reform Act and division regulations, policies and management decisions to enjoy 100 percent support.

"Unfortunately, the actions we take are going to have an effect on people that they might not see as a benefit to them," says Jimmy Johnson of Washington, commission chairman. The Fisheries Reform Act brought about many changes. But the challenge that remains before the commission and the division, Johnson says, is trying to manage fisheries for the good of all.

"It would be real easy to make certain species off-limits to certain segments," he says. "But that's the easy way out. It would be admitting defeat. It would be saying you can't do what you've been asked to do."

North Carolina Maririme Museum

Natural History is Second Nature at the N.C. Maritime Museum

BEAUFORT – The N.C. Maritime Museum logo depicts a beautiful old spritsail under full sail, a symbol of the museum's renowned work preserving, restoring and replicating the wonderful wooden boats of bygone days.

It also shows waves slapping the spritsail hull, a subtle reminder that the vessel was designed for the shallow waters it navigated; that in many and profound ways, the coastal environment shaped daily life along these shores.

"You can't talk about the fishermen without talking about the boat he uses and what he fishes for. It's all so intertwined," says public information officer Jane Wolff. Hence, the museum's mission to document, collect, preserve and research the maritime history - and its corollary natural history – of coastal North Carolina.

The popular state-owned attraction in downtown Beaufort itself was formed by its watery surroundings, and human fascination with them. Officially established in 1975, it got its start a century ago with some marine bird skins and fishing gear, part of an exhibit for an international fishing exposition.

In about 1904, the items went on display at the federal marine laboratory on Pivers Island, now under the National Atmospheric and Oceanic Administration. Preserved marine specimens used for scientific study were added, as well as fish and plant mounts and models. This nucleus of today's museum was housed on Pivers Island until the state took custody of the collection in the 1950s.

As they had throughout its history, the marine science community, state and federal agencies and dedicated individuals who wanted a museum in the county kept the collection viable through several moves and administrative changes over the next two decades.

Charles McNeill became the first curator and director in 1975, a defining development for what was then known as the Hampton Marine Museum. A graduate of the U.S. Merchant Marine Academy, a World War II veteran and a former operations manager for the N.C. State Port Authority, McNeill broadened the museum's scope to include maritime history.

In 1984, the name was changed to the N.C. Maritime Museum, and the museum was given its own designation under the N.C. Dept. of Agriculture, apart from the N.C. Museum of Natural Sciences, which had overseen it since 1959. A year later, it moved from rented storefronts in Beaufort to its current 18,000 square-foot, cedar-shingled Front Street quarters. The adjacent Harvey W. Smith Watercraft Center opened in 1992.

> ***"A marsh, a tidal flat, a barrier island - those are our classrooms...."***
> ***JoAnne Powell***

The N.C. Maritime Museum, now a division of State History Museums under the N.C. Dept. of Cultural Resources, has expanded to include facilities in Manteo and Southport, and it is growing again. The museum is embarking on two projects that will greatly increase its Beaufort presence - the completion of the watercraft center site, and the development of 36 acres of waterfront property. Owned by the Friends of the N.C. Maritime Museum, the property known as the Gallants Channel Site is about a mile from the Front Street facilities.

A World of Wonder

While much has changed and more change is on the horizon, the museum remains committed to raising awareness of the nature of the coast.

Visitors, which number 180,000 to 200,000 per year, learn much just by strolling through. Marine life models and exhibits are intermingled with maritime artifacts. The jaws of a great white shark jut above a doorway, surrounded by red drum, cobia, wahoo and other game fish.

A dolphin and a dolphin skeleton are suspended overhead, above other eye-catchers such as a model of a sea turtle carapace. "Discovery Carts," staffed by museum volunteers that are vital to many programs, feature changing assortments of such things as fossils and flotsam. A 5000-piece sea shell collection lines the auditorium walls.

A display of plastic litter found on a barrier island was meant to be temporary. The somber scenario includes photos of seabirds entangled

The North Carolina Maritime Museum
315 Front Street
Beaufort, NC 28516
252-728-7317
maritime@ncmail.net
www.ah.dcr.state.nc.us/sections/maritime

Established: 1975; roots go back to about 1900.
Staff: 21; approximately 125 volunteers.
Visitation: 180,000-200,000 annually.
Mission: The N.C. Maritime Museum documents, collects, preserves and researches the maritime history - and its corollary natural history - of coastal North Carolina for the purpose of interpreting this history through educational services and exhibits for our contemporary society, and passing intact its material culture to future generations.
Accreditation: The N.C. Maritime Museum is accredited by the American Association of Museums, and is a member of the Council of American Maritime Museums.
Departmental Affiliation: The N.C. Maritime Museum is a division of the State History Museums, N.C. Dept. of Cultural Resources.

in plastic soda bottle rings.

"It's been up for years because it generates so much reaction from visitors," Wolff says. "I like to think it's helpful."

Those who want to go further have more than 300 chances a year – collecting cruises, marsh treks, fossil hunts, plant identification hikes, bird watching, shelling, canoeing and kayaking, crabbing and clamming and even foreign ecotours. The museum also hosts 10,000 school children annually on-site and on cruises and field trips, and offers week-long children's summer science schools. It recruits internationally known scientists from the wealth of marine laboratories in the county to speak to groups and help with exhibits.

The Cape Lookout Studies program uses a former Coast Guard station on Cape Lookout National Seashore as a field station. The facilities enable overnight sessions on dolphin and sea turtle behavior and biology, barrier island ecology and photography. Cape Lookout Studies has since 1985 monitored dolphins that live in the area or migrate through via a photo-ID system, the longest running study of its kind.

The museum was a pioneer in environmental excursions, now common along the nation's coasts. The first education staff members were local science teachers. They had developed marine science and conservation curriculums for their students, rare in that era.

"In the 1970s, that was a new concept," says Wolff, who has been with the museum since 1975. The small staff began leading grown-ups into the marshy domain of periwinkles, mud snails, egrets and fiddler crabs, just as they had students.

> ***"You can't talk about the fishermen without talking about the boat he uses and what he fishes for..."***
>
> ***Jane Wolff***

"They were being subtly introduced to the fact that these things were important." Woff says. The trips also included other habitats such as ocean beaches and mud flats.

Education curator JoAnne Powell was one of those former science teachers who joined the museum in its early days. Her philosophy has always been that the value of the environment is a vital curriculum, and nature is an effective instructor.

"We feel we need to teach people natural history," she says. "And not just open the door, but get people involved in what this area is all about."

Despite its heavy load of educational enterprises, the museum has to date never had a classroom.

"A marsh, a tidal flat, a barrier island - those are our classrooms," Powell says.

The Past and the Future

Classroom space is planned in the completion of the Harvey W. Smith Watercraft Center site across Front Street from the main building, along with a deck, more docks and boat slips, a museum store and more area for marine life displays. The late Evelyn Chadwick Smith donated the land on which the current 6,000 square-foot boatshop sits, as well as the land for the main building. Named for her husband, the watercraft center houses wooden boatbuilding, boat restoration and model-making programs.

At the Gallants Channel property, the Friends of the N.C. Maritime Museum have invested $500,000 on site design, land improvement, development and construction of docks and buildings. Currently the museum sponsors public programs, adult and junior sailing programs and rowing programs at the property.

Future plans for the Gallants Channel site include a welcome center, a conference center and lodge, a shipwreck exhibition hall, a museum of recreational and working boating in North Carolina, a turn-of-the-century maritime village, a marine railway and boat workshop with a working foundry and sawmill, and a performance amphitheater.

An environmental learning center, a wildlife preserve and trail system, marsh and wetland habitat exhibits, a marina, docks and boardwalks will highlight natural history. Water taxis and ground shuttles will ferry visitors between Gallants Channel and Beaufort, Morehead City and Bogue Banks.

> ***"We really believe there is something for everyone at the North Carolina Maritime Museum system..."***
>
> ***David Nateman***

A coming cultural, social and economic boon to the region has accelerated the progress of some development. In two years, the museum will host a gathering of tall ships– the Pepsi Americas' Sail 2006. Trophies for the Americas' Sail competition along the coast of South America will be awarded in Beaufort in July, 2006.

Museum Director David Nateman expects the grand and elegant vessels and related events to attract many visitors.

"We really believe there is something for everyone at the North Carolina Maritime Museum system," he says.

Now in the business of environmental education for almost 30 years, museum staff members are seeing that their programs do have a lasting impact. Children and grandchildren of early participants are walking the same beaches and wading in the same marsh tidal pools on museum field trips, learning the same lessons of conservation.

The museum's guest book reflects its status as a state, national and international attraction. But it also has a legion of local enthusiasts who sign up repeatedly for outdoor adventures. Sara Page and her husband of Smyrna have forayed among the spartina and sea oats on many museum trips.

"We've seen some amazing things," Page says. "We are so much more aware of what's around us."

N.C. Sea Grant Helps Coastal Residents Meet the Rising Tide of Change

MOREHEAD CITY – North Carolina Sea Grant casts a wide net over coastal Carteret County's most fundamental issues. The federal and state partnership in marine research and outreach supports programs in fisheries, water quality, seafood production and mariculture.

> ***"Each proposal must identify a specific need in North Carolina..." Ron Hodson.***

As new concerns emerge, says N.C. Sea Grant Director Ronald Hodson, Sea Grant adjusts its focus. Recently created staff positions are aimed at assisting communities in meeting new stormwater regulations, and helping coastal businesses compete in dynamic markets.

"Our program has adapted over the years to meet changing demands along our coast," Hodson says. "Our research and extension efforts have encouraged sustainable economic development, as well as improved the quality of life for coastal residents."

Sea Grant's base funding comes from the National Oceanic and Atmospheric Administration, with matching funds from the General Assembly through an appropriation to the University of North Carolina (UNC) system. N.C. Sea Grant is headquartered at N.C. State University (NCSU) in Raleigh. Scientists from all 16 state universities and Duke University are eligible to apply for research grants.

"Sea Grant provides a direct and personal link between the universities and coastal communities," says Hodson.

Six extension staff with full or partial Sea Grant funding are based at the NCSU Center for Marine Sciences and Technology (CMAST) in Morehead City, and serve the entire coast as well as the county. Sea Grant has been working in Carteret County for more than three decades. Sea Grant also has offices in Manteo and Wilmington. Its mission coastwide is threefold: research, education and outreach.

Those goals fit the no-nonsense suggestions that coastal residents shared with former Sea Grant Director B.J. Copeland as the program was just starting. "To be accepted, Sea Grant would have to be relevant," recalls Copeland.

Early Sea Grant extension projects focused on the fishing and seafood industries. Bob Hines of the Carteret County office joined the staff in 1979. He has worked extensively with commercial fishers to adapt gear with turtle excluder and bycatch reduction devices, and with soft crab processors, using flow-through and recirculating shedding systems.

Hines also worked with shrimpers to demonstrate "skimmer trawl" gear that would take the catch from the top of the water column, rather than dragging nets along the sound bottom. It is now the predominant gear for inshore shrimpers along the central coast, he says. Hines ran the N.C. Commercial Fishing Show for many years.

In recent years, his duties have included coordination of the N.C. Fishery Resource Grant Program (FRG). Funded by the General Assembly, the FRG program provides $1 million a year for scientific research projects developed with those in the fishing and seafood industries.

"We work to pair the folks from the fishing communities with academics who have expertise in data format and analysis," says Hines.

Seafood and Science

The success of the FRG program led to a second state-funded effort, the N.C. Blue Crab Research Program. Again, many projects pair academics with fishers, such as tagging efforts in which crabbers worked with Duke University Marine Laboratory zoologist Dan Rittschof.

Sea Grant has had a role in shellfish research and extension as well. For 17 years, Philip "Skip" Kemp was a mariculture and marketing specialist, before moving to Carteret Community College in early 2004 to lead its aquaculture program.

Sea Grant's Seafood Science and Technology program has been closely tied to the NCSU Seafood Laboratory. Frank Thomas, an NCSU food science professor who is now retired, founded the Morehead City laboratory in 1970 with seed funding from Sea Grant. Sea Grant's seafood program and the food science laboratory are now located at CMAST.

"Established to provide technical information and applied research in support of the seafood industry, regulatory officers and consumers, the Seafood Laboratory has served the needs of North Carolina citizens and provided technology transfer

of science-based information to businesses," says David Green, associate professor of food science and director of the Seafood Laboratory.

Sea Grant's Barry Nash works at the laboratory to help seafood processors gain

North Carolina Sea Grant
NCSU Center for Marine Sciences and Technology
303 College Circle
Morehead City, NC 28557
252-222-6307
www.ncsu.edu/seagrant

Established: 1970
Staff: in Carteret County 6
Mission: Through research, education and outreach programs, North Carolina Sea Grant works with individuals, groups, government agencies and businesses to develop an understanding of the state's coastal environment and promote the sustainable use of marine resources.
Affiliation: National Sea Grant, National Oceanic and Atmospheric Administration

a competitive edge in a changing market. The surge in imported commodities that sell at lower prices, particularly crabmeat, has devastated the industry. A seafood technology and marketing specialist, Nash helps processors design safe, efficient manufacturing operations, and develop "value-added" or prepared seafood products for retail and food service markets.

> ***"We work to pair the folks from the fishing communities with academics who have expertise in data format and analysis..."***
> ***Bob Hines***

"As commodity distributors, our industry is at a competitive disadvantage with foreign businesses," Nash says. "Yet the domestic demand for pre-prepared seafood meals is steadily increasing. Numerous profit opportunities abound for the consumer-focused processor."

His work with several companies has resulted in over 50 new products, 10 of which are now on the market.

Sea Grant has partnered with the food science laboratory and state and federal agencies to provide Hazard Analysis and Critical Control Point courses for 630 seafood processors and dealers since 1997, when HACCP standards became mandatory. "Without this training, businesses would not meet federal requirements to produce seafood safely," Nash says. Operations that don't comply can be shut down.

Thousands of seafood consumers have benefited from Sea Grant programs on seafood handling information and serving suggestions. Volunteer "Nutrition Leaders" have worked with seafood education specialist Joyce Taylor to develop recipes that highlight North Carolina's catch. Their legacy continues in *Mariner's Menu: 30 Years of Fresh Seafood Ideas*.

"It is more than a cookbook. It is a seafood resource book," says Taylor, who officially retired, but continues to work part-time at the seafood lab.

Taylor also worked with Wayne Mobley of the N.C. Shellfish Sanitation Section to develop a workshop for environmental health specialists, who inspect seafood retail operations and restaurants. Nash and Mobley now coordinate the course with the UNC-Chapel Hill School of Public Health.

Current Events

While extension projects connect directly to communities, Sea Grant also funds research addressing issues important to the coast. Many involve Carteret County scientists.

For example, Hans Pearl, a professor at the UNC-Chapel Hill Institute of Marine Sciences in Morehead City, has conducted extensive studies on water quality in Pamlico Sound and the Neuse River Estuary.

Charles "Pete" Peterson, also a professor at the institute, is studying the recovery of habitat function following beach nourishment. Peterson also has National Sea Grant College Program funding to study the role of shellfish sanctuaries, in efforts to eliminate significant oyster diseases.

Jeffrey Buckel, an NCSU assistant professor in zoology with a research and extension appointment at CMAST, is conducting Sea Grant research on red drum, the state saltwater fish. He also is the adviser for the Marine Fisheries Management Fellowship, a partnership with the N.C. Division of Marine Fisheries. He has a partial Sea Grant appointment to collect and translate FRG project results into papers for academic journals.

NCSU zoology professor John Miller is looking at how flounder performance can identify the quality of various habitats. The data derived from the "stress tests" may also be considered during discussions of potential stock enhancement efforts.

"All Sea Grant research is applied science. Each proposal must identify a specific need in North Carolina," Sea Grant director Hodson says.

Two new Sea Grant extension specialists joined the Morehead City office this year. As a water quality planning specialist, Kate Ardizone is identifying sustainable growth and development issues that link land use to water quality. Since January, she has been working with coastal communities to meet new state requirements to control stormwater runoff and to update land-use plans under the Coastal Area Management Act.

Funded through a partnership with the Division of Water Quality, under the N.C. Dept. of Environment and Natural Resources, Ardizone's efforts will cover the state's coastline. She also works with Sea Grant water quality and coastal community specialists and other state agencies to provide a coordinated network of resources.

In early June, Brian Efland joined Sea Grant as a coastal business specialist. He will work with aquaculture operations, ecotourism, the commercial and recreational fishing industries and a variety of other businesses.

"The coastal economy provides opportunities and challenges, as new businesses emerge, and traditional fishing and seafood industries find themselves part of the global economy," Hodson says. "Sea Grant will provide a link to the latest economic research and business models."

Sea Grant has close ties with the Carteret County community. Office assistant Vanda Lewis is a Harkers Island native who has been with the Morehead City office for 17 years. Coastal residents help Sea Grant keep its projects current, says extension director Jack Thigpen, based in Raleigh. Sea Grant's outreach advisory board meets twice a year, drawing upon the expertise of coastal officials and people in the communities.

In addition, board members provide insight in developing Sea Grant's formal strategic plan, and in identifying potential extension, communication and education projects. Sea Grant also convenes North Carolina experts to review preliminary proposals for the two-year, major research project cycle, to ensure that suggested topics fit the state's needs.

"Our mix of community input and cutting-edge science has been the Sea Grant hallmark for 30 years, and will be our hallmark as we continue to serve coastal North Carolina in the future," Thigpen says.

Photos by Scott Taylor

North Carolina State University CMAST

Center for Marine Sciences and Technology

"Community" is the Key Word at NCSU Center for Marine Sciences and Technology

MOREHEAD CITY - Along North Carolina's vast coastline, countless living things depend on each other and their saltwater surroundings for survival. Every organism from plankton to whales are connected in these tightly woven webs of life – including people.

Humans have equal standing in the coastal ecosystem with dolphins, fish, crabs and other creatures, as viewed from N.C. State University's Center for Marine Sciences and Technology (NCSU CMAST).

"People are an important part of the coastal ecosystem," says David Green, CMAST director. "We are not above it or below it. What we do has an impact on other creatures in the system."

CMAST brings to bear NCSU's diverse scientific expertise on defining the parameters of that impact.

"Contrary to popular belief, we don't want to fish the last fish," Green says. "What we desire is sustainability. But one component of that desire is utilization of our natural resources to sustain our communities. It provides jobs. It feeds people."

> ***"People are an important part of the coastal ecosystem..."***
> ***David Green***

The consortium of scientists at CMAST reflects the challenge in finding the balance that permits use of natural resources without depleting them. Faculty and staff from three colleges and 17 departments engage in research, education, extension and outreach at the newest marine laboratory in Carteret County.

"Marine sciences is an interdisciplinary area," says Green, who has been CMAST director since 1999. "It's truly an area that requires expertise in many fields of study."

The CMAST building, overlooking Bogue Sound, opened in 2000. The General Assembly in 1995 funded construction of the 51,000 square-foot center as part of a larger effort to strengthen marine science education and research programs in Carteret County. NCSU leases the land on which CMAST stands from Carteret Community College.

CMAST is NCSU's first major facility on the state's shoreline, though the university has offered graduate programs in marine sciences since 1968. CMAST gives NCSU a "point of presence" at the coast, Green says, a crucial advantage in confronting new questions constantly arising as the human population continues to grow along our coastline.

In conjunction with research, CMAST also creates a conducive learning environment for graduate and undergraduate students, and facilitates extension and outreach efforts that give local residents access to the NCSU marine sciences faculty.

In addition, the high-speed internet connection provided through NCSU and extended to CMAST's community partners will soon be made available to other institutional partners. CMAST's high-capacity access opens a window on a world of new education opportunities for county residents through distance-learning.

"If people say that knowledge is power, then access to knowledge is what CMAST is all about. It's a shared resource to the benefit of our community," Green says.

Complementary Strengths

The specialties at CMAST complement the strengths of the two other university marine laboratories in Carteret County, the University of North Carolina at Chapel Hill Institute of Marine Sciences (UNC-CH IMS) and Duke University Marine Laboratory.

NCSU's reputation in fisheries is bolstered by CMAST's proximity to estuarine and marine environments. Jeffrey Buckel, an assistant professor in zoology with a research and extension appointment in the College of Agriculture and Life Sciences (CALS), oversees a number of projects and graduate students based at CMAST. He works closely with the N.C. Division of Marine Fisheries on studies of marine and estuarine finfish population dynamics.

CMAST's location fostered the creation of a Marine Fisheries Management Fellowship, based at CMAST and funded by N.C. Sea Grant and the N.C. Division of Marine Fisheries. Buckel is the NCSU mentor for the fellowship. The program gives post-graduate fellows fresh from an academic setting a chance to work in an applied setting, Buckel says. The benefits run both ways.

"At the same time, these young scientists just coming out of academics are bringing the latest ideas and approaches with them to the

North Carolina State University
Center for Marine Sciences and Technology
303 College Circle
Morehead City, NC 28557
252-222-6300
www.cmast.ncsu.edu

Established: Chartered in 1999, building opened in August 2000
Faculty and Staff: 36.5
Mission: To promote multidisciplinary studies among research scientists, educators and extension specialists from participating NCSU colleges, to improve our interaction with other educational institutions and agencies concerned with marine sciences and coastal natural resources, and to provide a focal point for citizen contact with NCSU's marine sciences faculty.

Division of Marine Fisheries," he says. Graduate students at CMAST also learn from the interaction with fisheries fellows.

The coastal location also reduces the constraints of travel. For example, master's student Kara Schwenke is working on an estimate of the age and growth of dolphin fish, gathering data from commercial and recreational interests. The last such study was done in the 1960s. Unlike that study, time and distance do not confine field work to the summertime.

"She can go out every month of the year," Buckel says.

The presence of NCSU's College of Veterinary Medicine (CVM) is one of CMAST's unique contributions to the area.

"Through CMAST, we're the only veterinary college in the U.S. that has a coastal presence," says Michael Stoskopf, a professor in clinical sciences at CVM, and a rotating CMAST faculty member. "We can be readily available to work on issues and questions that affect the coastal community."

Post-graduate, graduate and pre-veterinary students come to CMAST for aquatic medicine programs. But faculty members are most visible in their involvement in the community with sea turtles and marine mammals.

"Over the past 15 years or so, the CVM has developed some very innovative techniques in the surgical repair and medical treatment of turtles with trauma injuries from boat strikes, or physical debilitation from other causes, such as infectious disease," Stoskopf says.

> ***"The biggest benefit to my students is being able to interact with all the other marine scientists in that area...."***
> ***Dave Eggleston***

Craig Harms, an assistant professor in the clinical sciences department and part of CMAST's resident faculty, frequently cares for injured or ill sea turtles. Harms and other CVM faculty also tend to marine mammals that come ashore alive, and look for possible threats to the larger population when animals wash up dead. All these encounters are used as teaching opportunities.

Less publicized is CVM's work on medicine for other marine life.

"A lot of the major reference books on fish medicine come from our faculty," says Stoskopf, an author of one himself. Greg Lewbart, a clinical sciences associate professor in aquatic medicine and a CMAST rotating faculty member, will soon publish a volume on invertebrate medicine.

And still other CVM faculty members such as Ed Noga and Jay Levine are well known in the aquaculture and coastal fisheries community.

Looking Outward

David Eggleston, a professor in marine, earth and atmospheric sciences under the College of Physical and Mathematical Sciences, has several doctoral students and projects based at CMAST. A study of the effects of meteorology on water circulation and the resulting influence on population patterns of fish and blue crabs in Pamlico Sound involves students from several coastal high schools. The students collect useful data on the post-larval stages of crabs, while their participation increases their scientific literacy.

Other projects concern how blue crabs respond to low oxygen in the water, the relationship between land use, water quality and the resiliency of different ecosystems to multiple stressors, and whether fish growth rates reliably indicate the quality of habitat and nursery areas. CMAST simplifies the logistics of these studies.

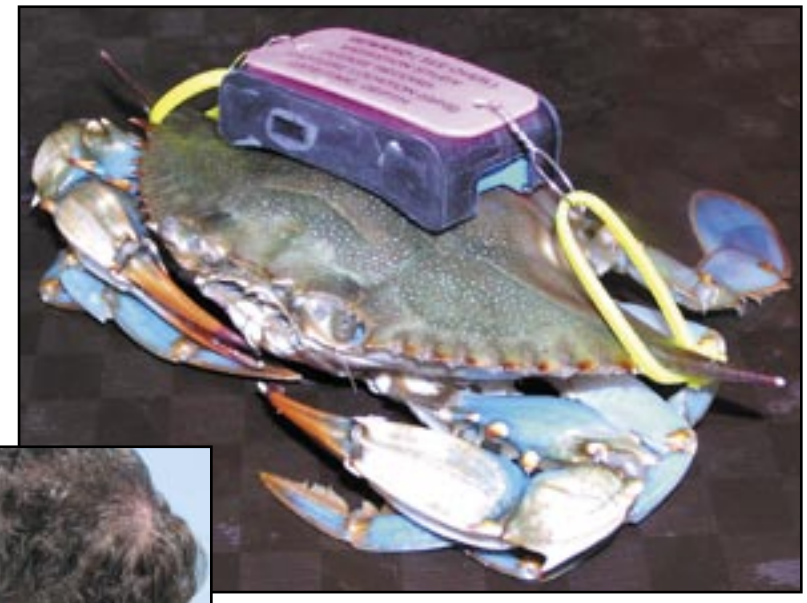
"Now we can keep boats and personnel and equipment at the coast," he says. Carteret County is home to a number of state and federal marine sciences operations, which provides another advantage.

"The biggest benefit to my students is being able to interact with all the other marine scientists in that area," he says. "It's been a nice sort of synergism."

> ***"We can be readily available to work on issues and questions that affect the coastal community...."***
> ***Michael Stoskopf***

The Seafood Processing Laboratory, a unit of the Food Science department in CALS, has been operating in Carteret County since 1970 and now is integrated into CMAST. The laboratory has a long history of research and extension in seafood safety and utilization. It supports several educational programs, including courses to help seafood handlers meet federally mandated seafood safety regulations.

A current emphasis is the development of "value-added" products, in which safety, quality and appeal are heightened by post-harvest handling, processing and distribution. Barry Nash, a Sea Grant seafood technology and marketing specialist working in the laboratory, has helped processors develop more than 50 new products.



"His work helps the industry and small businesses diversify markets, and create new jobs," says Green, who is a food science associate professor, and directs the seafood laboratory in addition to CMAST. Green's latest research efforts concern reducing histamine-causing bacteria in scombroid fish such as tuna, and assisting entrepreneurs across the state with aquatic food products.

In the immediate future, two new saltwater laboratories will enhance research into environmental effects on marine organisms. In a cooperative agreement, the labs are located at UNC-IMS and dedicated to NCSU use.

And Green expects expanded research in water quality, environmental toxicology and oceanography. NCSU and CMAST have major roles in two comprehensive ocean observation systems, using shoreline instrumentation and offshore buoys. More undergraduate programs - and more facilities - also are ahead. Green is working on funding to build a dormitory for resident students and visiting scientists, and expects to break ground in 2005.

CMAST provides two critical perspectives in the relationship between people and our natural resources, Green says. The coastal center brings a multidisciplinary approach into day-to-day contact with environmental challenges as they emerge. Just as important, CMAST scientists draw upon the combined wealth of information and expertise of the marine sciences community as a whole.

"By locating here, we are part of the community and have the ability to study the environment up close," he says. "And we have access to knowledge and the resources to look at the long-term issues impacting our coastal communities."

University of North Carolina at Chapel Hill IMS

Institute of Marine Sciences

When the Coast Has a Problem, IMS Scientists Have a Plan

MOREHEAD CITY - If a coastal concern is in the headlines or the topic of morning coffee conversations, chances are it is under study at the University of North Carolina at Chapel Hill Institute of Marine Sciences (UNC-CH IMS).

"I often package our mission in the following simple words – to provide public service through research," says John Wells, who led IMS as director for the past 11 years. "And that research has a fundamental, immediate relevance to the citizens of North Carolina, who pay our salaries and provide support for this facility, and have for over 50 years."

Now ranked among the best of its size in the nation, the university marine laboratory was established in 1947 as the Institute of Fisheries Research. It was renamed in 1967 to reflect its broad scope of interests, and faculty specialties remain diverse. What much of the research has in common, however, is pertinence to coastal policy.

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> ***John Wells***

"Our mission is a science mission," Wells says. "We provide the science, but we can step forward and talk about the reality of how that science ought to be used." Applying research findings in a societal framework is no simple task.

"I tell my students the coastal environment is where science, policy, economics and politics are very tightly intertwined," he says.

Beach nourishment is a prime example. Periodically pumping dredged sand onto shrinking beaches is now a common community response to oceanfront erosion in North Carolina and most East Coast states.

The dynamics, economics, effectiveness and wisdom of such methods to protect structures are under debate in political and environmental arenas. Crucial questions IMS is attempting to answer, Wells says, involve the long-term performance of the projects, and their impacts on biological resources.

"If you let the time line go out over a few years or perhaps a decade, some of that sand is going to disappear," he says. "Where is it going? Why is it disappearing? How can we better design nourishment projects to increase their longevity or reduce their costs?"

Other questions concern the immediate effects of nourishment on crabs and other organisms that live on the bare sand beach, the cumulative impact of repeated projects on those creatures and the differences in sand on a natural beach and that taken from the sea bottom.

"People here are looking at the biology as well as the sedimentology of beaches," Wells says. "This issue is going to be with us for a long time."

IMS researchers are regarded for their commitment to long-term research on complex issues. Wells himself is noted for his work in coastal marine geology. Water quality and shellfish revitalization are just two of the other areas where IMS researchers have made a difference, he says.

"Hans Paerl is an international expert in nitrogen loading, the nutrient problems in rivers and estuaries, the impact on fish because of the deprivation of oxygen," Wells says. Reducing the sources of nitrogen can help prevent fish kills that occur periodically, and the algal blooms that cause other problems.

Other IMS researchers have focused on methods to restore shellfishing stocks, and to harvest seafood with less impact on the surrounding ecosystem.

"Pete Peterson has spent his entire professional career at IMS working on a wide range of fishing – particularly shellfishing – studies that give us insight into how to better design oyster reefs; how to trawl and dredge; how not to trawl and not to dredge; how to do things in stressed fisheries to bring those back to where they are viable," Wells says.

Among other things, IMS scientists are also looking at the movement of water - and the fish larvae it carries - through inlets, the role of viruses and bacteria in marine environments and possibilities for using marine plant and animal products in sunscreens and medicines.

Because many pressing issues reach well beyond North Carolina shores, IMS funds a number of investigations important to the state through federal grants and programs.

A New Direction

As a UNC-CH research unit, IMS hosts up to 25 graduate students a year. In the fall of 2003, IMS became a field site for UNC-CH's Carolina Environmental Program (CEP), and for the first time ever, offered a

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Established: 1947
Faculty and Staff: 62
Mission: The Institute's mission is to serve the state and nation through the conduct of high-quality basic and applied marine sciences research.

full semester of undergraduate coursework.

From the IMS standpoint, Wells says, the arrangement strengthens the connection with its home campus, and enhances the institute's place in the UNC-CH organization. Undergraduate education presents a big change for a research organization, but CEP enjoyed full support in its first session.

"Almost every faculty member at the institute participated in some fashion," says Wells.

Five students from the CEP, a multidisciplinary environmental undergraduate degree program at UNC-CH, were enrolled for the semester last year, and seven are signed up for 2004. The IMS component is offered in the fall.

Maximum exposure to the coastal environment is built into the program, says site director Rachel Noble, a marine microbial ecologist, and an assistant professor for both IMS and CEP.

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> ***Rachel Noble***

"Getting them out on the water is a huge part of what we do here," she says. "We want them to know what real research in the marine and aquatic sciences is all about." Last fall's students spent at least one day a week in the field, sometimes two or three, often working on active research projects.

"We want them to understand the relationship between science itself and public policy and conservation," Noble says. "We want them to know how those management people out there actually get the data that they use to make their decisions." CEP students also interact with a number of

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> ***Richard Luettich***

scientists besides those at IMS through guest lectures and an invited speaker seminar series.

Students choose their own subject for an independent research project or an internship. They also work together on a "Capstone" research project on a topic of mutual interest. The first class selected beach nourishment. Each student chose a facet of interest to them, such as the economics or the biological effects. The five compiled their findings in a report made available to future students, should a future class choose to expand on it in another Capstone effort.

The first CEP participants gave the semester high marks. UNC-CH biology major Juliana Miller from Blounts Creek says the experience and the IMS faculty reinforced her career choice.

"I realized marine ecology was definitely what I wanted to specialize in," she says, "And that the people you work with are key."

Leadership Change

A major change for IMS is the departure of John Wells. He left this summer to become dean of the School of Marine Sciences at the College of William & Mary in Williamsburg, Va., and director of its Virginia Institute of Marine Sciences.

"I've truly enjoyed the 20 years I've spent here," he says. But someone else can bring new ideas and new vision to IMS, he says, just as he hopes to do for William & Mary. He wants his mark as IMS director to be the institute's tangible link to coastal communities and what they care about.

"I want the public to think of IMS as a resource," he says, "a resource for the community, and the state."

Professor Richard Luettich, who has been at IMS for 17 years, has assumed the directorship. He expects to continue the close relationship between IMS and coastal citizens. An example: IMS is participating in the development of a national network of ocean observation systems. A research buoy deployed off Cape Lookout as part of that network will provide real-time wave, wind and current conditions.

"I think that will be very helpful to the recreational and commercial fishing industries, and to the community," he says.

Wells "cast a long shadow" in many ways, Luettich says. One of Wells's most visible and significant accomplishments at IMS, he says, has been the transformation of the institute's aging facilities. Renovation and construction under Wells's direction over the last 10 years have greatly expanded, updated and improved offices, fieldwork support facilities and laboratories for students and faculty members from campus, as well as from IMS itself.

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> ***Juliana Miller***

"We're in terrific shape, finally, from a facilities perspective," Luettich says. "Now we're looking forward to expanding the research and the services that we provide." Three additional faculty members are expected to join IMS in the next 12 to 18 months, specializing in wetlands ecology, coastal geology and sediment transport.

Luettich says he is excited about the challenge of leading the UNC institute at this critical time for the coast.

"I think the North Carolina coastal zone is only going to increase in its importance to the state," he says. "And at the same time, the pressures to sustain it as a high-quality resource are only going to increase, too."

Marine Science and Education Partnership

1 - Carteret Community College
2 - Duke University Marine Laboratory
3 - National Oceanic and Atmospheric Administration
4 - North Carolina Aqarium at Pine Knoll Shores
5 - North Carolina Division of Marine Fisheries
6 - The North Carolina Maritime Museum
7 - North Carolina Sea Grant
8 - North Carolina State University
9 - University of North Carolina at Chapel Hill

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